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Validity of Specific Leg Muscle Strength Test Instrument For Volleyball (Volleyball Squat Max Strength Test)

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ABSTRACT

This study aims to develop the Volleyball Squat Max Strength (VSMS) Test instrument, as a measuring tool for leg muscle strength in volleyball athletes at the State University of Malang, by emphasizing the validity aspect. This research used the 4D Research and Development instrument development method involving 50 volleyball athletes at the State University of Malang. The validity test includes content validity, construct validity and criterion validity. The results show that the Volleyball Squat Max Strength (VSMS) Test instrument is feasible to use according to experts and has an r count of 0.82459, which is greater than r table 0.2732, so it is declared constructively valid. For the correlation test results, r count 0.7644 is greater than r table, so it is declared to have a very high correlation with the standard instrument. This instrument is much more valid for measuring leg muscle strength than the existing instrument, the leg dynamometer, because it is more specific to the characteristics of volleyball. It should be emphasized that this study did not include reliability testing or norm setting, so these findings still require further development for wider application.

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A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
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INTRODUCTION

Leg muscle strength is one of the components in supporting the performance of volleyball athletes because it plays an important role in various explosive movements such as jumping, landing, lateral acceleration, and changing direction (Oktariana & Hardiyono, 2020). In the game of volleyball, leg muscle strength is one of the most important components of physical condition. Explosive movements depend on optimal leg muscle strength. Therefore, the measurement of leg muscle strength is an important aspect in the process of coaching and evaluating the performance of volleyball athletes. (Query et al., 2010).

Existing leg muscle strength testing instruments, such as the leg dynamometer, are still less specific in assessing aspects of maximal and functional leg muscle strength in volleyball games. This is due to the measurement position on the leg dynamometer,

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which uses a knee angle of about 120 degrees, which does not represent the movement in volleyball. The functional movements in question are typical in volleyball sports that use a squat position with a squat knee angle of 90 degrees, such as passing, block prefixes, smash prefixes and receiving (Caldeira et al., 2024). Therefore, a more specific test tool innovation is needed.

In the world of coaching and coaching volleyball athletes, measuring leg muscle strength is an important aspect of evaluating and improving athlete performance (Putri Isabella & Perwira Bakti, 2021). However, the currently available test instruments are still general and not fully specific to volleyball. For example, the leg dynamometer test is often used to measure leg muscle strength, but it does not directly reflect the specific needs in volleyball movements, such as the combination of jumping, landing, and reaction to the game.

The development of specific leg muscle strength test instruments for volleyball is very urgent, considering the limitations of test instruments that are general in nature and less able to represent functional needs in volleyball games. In addition, the absence of specific valid measurement tools can cause the athlete selection process, monitoring training progress, and developing coaching programs to be suboptimal (Marpaung & Priyonoadi, 2020). This has the potential to hinder athlete development and training effectiveness. Therefore, the development of instruments that are in accordance with the characteristics of volleyball movements is a strategic need that supports the overall improvement of athlete performance (Hutomo, 2020).

The absence of test instruments specifically designed for volleyball can be an obstacle to providing more accurate data for coaches and athletes. Therefore, it is necessary to develop test instruments that are more specific and in accordance with the needs of movements in volleyball games (Sidik, 2016). The development of this instrument is expected to measure leg muscle strength more accurately, relevantly, and applicable in the context of volleyball games.

The test instruments developed specifically for movements in volleyball produce relevant and functional tests. This will support a more effective and targeted training program in improving athlete performance. (dos Santos et al., 2015) said that if physical tests are designed following the functional needs of a sport, the test results will be more accurate and reliable in reflecting the athlete's performance ability when competing. The development of test instruments that are specific to the characteristics of sports movements allows coaches and athletes to obtain more valid and reliable data in assessing certain physical capacities (Jonas Solissa, 2023). Therefore, this study aims to develop a leg muscle strength test instrument that suits the specific needs of volleyball sports.

METHODS

This research is a study that uses the 4D Research and Development instrument development method. The 4D development model is a development model consisting of

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4 stages, namely Define, Design, Develop, and Disseminate (Indaryanti et al., 2025). But this research only reached stage 3, because the research only reached the validity test without continuing to the reliability test stage or the preparation of norms, so that the Dissemination stage could not be carried out. Parentheses and set on the right margin.

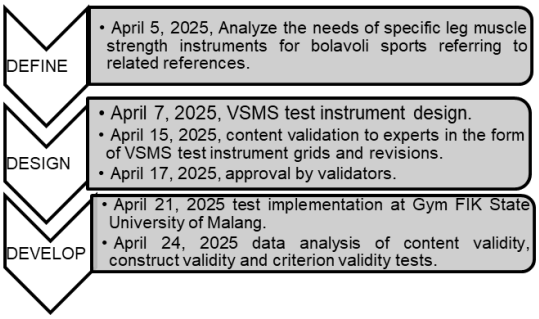

Figure 1.
4D Research and Development Diagram

The steps in this development model, namely, the first step to define the stage of collecting needs that will be used as a test instrument for leg strength in athletes. Design is planning and making instrument grids on questions for experts. Develop or develop a development product that is carried out by testing content validity, construct validity and criterion validity. 2 Instrument evaluation experts to see how appropriate the test instruments used are, while expert practitioners to trainers discuss the instruments used. According to (Asiva Noor Rachmayani, 2015), in developing the instrument, it is necessary to involve experts who have academic competence and experience in the world of coaching for more than two years. The samples of this study were Volley ball athletes and Volley ball specialization classes at the State University of Malang. According to (Creswell et al., 2012), in development research using 30 samples, for more stable and generalizable results, it is better to use 50 - 100 samples, and volleyball athletes who are tested must have a minimum of two years of training. This validity test uses construct validity and criterion validity between the Volleyball Squat Max Strength (VSMS) Test instrument, and a standard leg dynamometer instrument. According to (Baumgartner, TA, 2017) in the development of sports tests, the scores of physical measurements such as muscle strength are taken from several trials or items, then tested for validity against the total score. This analysis technique uses the Pearson product moment formula (Derick, 2015).

The implementation of the VSMS test begins with the athlete's initial position, standing in a semi-squat position with knees bent ± 90 °. The subject performs a full squat and holds the squat position for 3 seconds, then pushes up with maximum strength while holding a weight tool at 50% of body weight. The load was then added 10 - 20% gradually until reaching the maximum repetition. The test was performed twice with a break of 2 - 3 minutes, and the highest score was taken as the final result. Before the test, participants warmed up and received technical instructions to ensure safety and consistency of execution.

RESULTS AND DISCUSSION

Result

This research was conducted to test the validity of the Volleyball Squat Max Strength (VSMS) Test instrument. The results of the validity of the Leg dynamometer standard instrument are valid, so it does not need to be listed only as correlated with the development instrument product.

Table 1.
Results of the Volleyball Max Strength (VSMS) Test Content Validity Test

No	Experts	Presentation	Description
1	Instrument Evaluation expert	85,5%	Valid
2	Sport Coaching Expert	87,5%	highly
Totally		**86,5%**	

Table 2.
Results of the Volleyball Max Strength (VSMS) Test Construct Validity Test

Test Item	N	M±SD	r Count	Criteria
Volleyball Squat Max Strength Test	50	67,4±18,4566	0,82459	valid

Table 3.
Volleyball Squat Max Strength (VSMS) Test Criterion Validity Test Results.

Test Item	Test Item Standard	N	M±SD	r Count	Conclusion
Volleyball Squat Max Strength Test	Leg dynamometer	50	124,523 ± 36,8917	0,7644	Very High

Discussion

Based on the results of the content validity test conducted by two experts, the VSMS instrument for volleyball athletes shows a very good level of validity. Content validity is obtained through an assessment from experts who understand the substance of the material and measurement techniques. An instrument is said to have good content validity if the test items representatively reflect the domain being measured (Arsi, 2021) dan (Patrick et al., 2011). The average percentage value of the two validators indicates that the instrument has a high level of confidence to be used in measurement. There are several revisions from validators, such as test procedures that have a high risk of injury; therefore, to be considered when doing the test, athletes must really warm up first. This strengthens that the instrument developed has met the content validity following the field of expertise of each validator.

The results of the construct validity test of the Volleyball Squat Max Strength (VSMS) Test show that this instrument has very high validity, with the calculated r value far exceeding the r table value at the commonly used significance level. (Sattler et al., 2012) said that for the construct validity test, r-count must be greater than the r table statistically. This test was conducted on 50 athletes with a mean test result of 67.4 standard deviation of 18.4566, which indicates that there is variation in performance between individuals. This high correlation value indicates that the VSMS Test can accurately represent the construct to be measured, namely, the maximum strength of squats in volleyball athletes. The high construct validity confirms that the test items in

this instrument truly measure the physical aspects relevant to athletes' performance in volleyball (Lopes et al., 2016). Especially in functional movements. Thus, the VSMS Test can be used as a relevant measurement tool in the context of training and research, because it is able to provide precise and useful information for planning strength training programs and evaluating the development of athlete performance.

The results of the criterion validity test of the Volleyball Squat Max Strength (VSMS) Test instrument show a very strong relationship between the VSMS instrument and the standardized leg dynamometer. Criterion validity is a form of external validity that shows the extent to which the measurement results of the new instrument have conformity or consistency with measuring instruments that have been considered valid and reliable (Indaryanti et al., 2025). (Borsboom & Markus, 2013) says that criterion validity is a type of validity that shows the extent to which the results of a test correlate or match an external criterion that is considered a standard or reference. This provides a strong basis that VSMS is not only theoretically relevant (constructively valid) but also able to produce data that is in line with standardized tools used in measuring leg muscle strength, so it can be relied upon in the context of physical evaluation of volleyball athletes. The advantage of VSMS lies in its ability to measure maximal strength in functional movements that are more in line with the characteristics of volleyball sports movements.

Leg muscle strength is also an important element that must receive serious attention. Muscle strength in the legs is needed to carry out basic techniques such as serving, passing, and blocking in volleyball (Putri Isabella & Perwira Bakti, 2021). Strength training programs should be tailored to specific needs based on the player's position. Although strength is a major factor in volleyball's physical requirements, endurance remains an important component. Athletes with good muscular strength can maintain high performance during matches and are better able to overcome fatigue. In addition, strength also plays an important role in preventing injury and increasing the range of motion. (Yoga et al., 2023) The research instruments developed make an important contribution to designing a more comprehensive and in-depth training strategy. The instrument products developed, especially in functional movements, strongly refer to the game of volleyball, such as when the squat test is held for 3 seconds, like the position of a volleyball athlete when receiving a serve for approximately 8 seconds. (Maulana et al., 2021) said that the test data allows the coach to make more focused and targeted interventions, for example, athletes who score low on the leg muscle strength component will be given a special training program that focuses on increasing muscle and upper body strength. (John et al., 2021) suggests that the variability of test results can be influenced by external factors such as physical condition, test execution technique, and level of experience in performing explosive movements. Athletes who have a consistent training history usually display more stable performance and are able to maximize their physical potential more effectively.

The instrument developed in this study has different characteristics compared to existing methods. Its main advantage lies in its ease of implementation in the field. The

test was designed with a practical approach, allowing for a more stable and functional implementation. According to (Wijayanto & Siahaan, 2022), the effectiveness of a measurement tool depends not only on the accuracy of its results but also on its ease of use and availability. Instruments that do not require complex equipment are flexible and easy to apply in a variety of training situations. Meanwhile (Villarejo-García et al., 2023) highlight that a valid measuring instrument that has a high level of accuracy is a very valuable strategy, especially in the athlete training process. The suitability of the instrument to the specific movement characteristics in volleyball is the main advantage that distinguishes it from standardized tests. This instrument can also describe the athlete's physical potential more precisely. However, this tool still has methodological limitations. Technical differences between athletes can lead to inconsistent measurement results. Factors such as individual differences, mastery of techniques, and experience during the test can cause bias. Therefore, according to (Kusumawaty et al., 2022) Implementing standardized procedures is essential to reduce variability in measurement results.

This research makes a meaningful contribution in designing test instruments to measure the physical condition of volleyball athletes, especially in leg muscle strength, with a focus on accurately measuring fitness and arm strength. Different from research (Henriksen et al., 2010), while this study focuses more on assessing athlete performance in general, it offers a more specific and in-depth approach in supporting the athlete development process. Meanwhile, research conducted by (Doewes et al., 2023) has indeed supported the importance of objective measurement of athletes' physical abilities, but has not yet reached the level of detail and equivalence achieved in this study. This research makes an important contribution by presenting a physical condition test instrument that is not only proven to be valid but also highly customized to the specific needs of volleyball athletes. Different from the generalized approach in previous research, this study presents a comprehensive solution to disseminate and understand the potential strength of athletes at a crucial stage in the sports development process.

The Volleyball Squat Max Strength (VSMS) Test instrument can be practically utilized by clubs and coaches to monitor the physical development of athletes thoroughly and objectively. The main advantage of this instrument lies in its ability to present data-based assessments, replacing selection methods that have so far relied more on the subjective judgment of the coach. According to (Briesch et al., 2016), to make the measurement results more consistent and generalizable, future research should involve a more diverse sample, including athletes from different clubs, regions, and backgrounds. This step is important to ensure that the strength and arm measurement instruments are truly widely applicable with high accuracy. A further recommendation is the need to develop additional tests to assess other aspects of physical condition, such as endurance and agility of volleyball athletes. (Martinez, 2017) emphasized that performance in volleyball is not only dependent on fitness and strength, but also involves other physical abilities. The development of more comprehensive tests will provide a fuller picture of the athlete's potential and training needs. By tracking an athlete's

development to the professional level, researchers can make the instrument as effective as possible in predicting future performance and potential. This long-term approach will be an important reference for coaches and trainers in developing more targeted and effective athlete training programs.

CONCLUSION

This study states that the Volleyball Squat Max Strength (VSMS) Test instrument is constructively valid. The criterion validity test serves to assess the extent to which the measurement results of the developed instrument have a significant relationship with other measuring instruments that have been proven valid (standard instruments). It can be concluded that from a series of validity tests that I used, starting from the content validity test, construct validity and criterion validity, the results showed that the instrument I developed was valid and significant or consistent with the standard measuring instrument, namely the leg dynamometer.

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